

## Serious Games for Training and Education on Defense against Terrorism

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### **ABSTRACT**

*This paper proposes a serious games application, named Sibilla devoted to simulate intelligence agencies. The project was developed by a distributed international team to develop a training tool for learning group dynamics and information management in a counter-terrorism scenario.*

*The application is web-based, built on game theory for competitive and co-operative training over a network using intelligent agents to manage the data.*

*In terrorism prevention and, in general, in asymmetric warfare operations it is crucial to collect and validate as much information as possible. Information usually comes from several, different sources often not trusted.*

*Decisions makers can be overwhelmed from the huge amount of data collected from wide informative sensors networks: among these data it is necessary to identify what to evaluate and what is not true (either accidentally or due to counter information activity), which is the value of information; at the same time some important info could be missed by some organisation and collected by other ones.*

*Collaboration and data analysis are the two main skills that can be trained by Sibilla.*

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### 1. INTRODUCTION

Non conventional warfare (asymmetric or terrorism) is, and will remain, a central threat in the international scenario. Security forces (armies and intelligence) are involved every day to prevent and operates against this kind of threats both in domestic and in international scenarios.

Sibilla in particular is focused on a counter terrorism actions in a single nation where intelligence agencies are co-operating in these activities, keeping in mind their identity and peculiar goals..

Both in reality and in Sibilla there is a large galaxy of terrorists groups that operates; their aim are not always clear and often there are alliance between different organisations that lead to act of violence.

It's difficult getting reliable information about terrorist's activities even for the growing number of them and the surprising links between them. In Sibilla players are acting as Intelligence and Security Agencies Directors and have to value intelligence information in real time and mine them. They have to understand the importance to share and check data arriving from different sources (official or not, trusted or not, etc...). In fact information sources can be very different and they can be the clue for the same criminal plan. In Sibilla, exactly as in real life, different agencies can have different pieces of information useful and complete only if they are in a right scheme. This is the only way to understand plans of criminal minds and successfully prevent attacks

Serious games are nowadays a largely consolidated tool to train staff in defence sector

### 2. SIBILLA

Sibilla (Simulation of an Intelligent Board for Interactive Learning and Lofty Achievements) is a computer based serious games developed to train the staff involved in preventing terrorist attacks forcing them through the game to learn to share information, value the quality of information and improving their analysis skills (Bruzzone et al.2009); in fact Sibilla core is represented by a web based distributed stochastic discrete event simulation (Bruzzone et al.1999).

Players in this game are the higher level operators in the counter terrorist agencies; they have to front incipient terrorists threat on their territory. Aim of the games is to understand what terrorist want to do using the information they can collect and prevent in this way the attacks.

More in general Sibilla is devoted to train:

- Management of competitive and/or co-operative environment,
- to pay attention on importance of maximum utilisation and effective uses of group resources,
- to analyse data and to stimulate analysis of problems of gathering and assessing information
- to understand the importance of co-operation and in particular of sharing information among partners and allied groups.

It could be applied to organisational staff, managers and individuals to increase their awareness of such values and threats.

It's also important to underline that Sibilla can be used either by groups and individuals with different goals. Individuals can improve analysis capability while for groups it's also possible to develop relationship and negotiation capabilities and group management skills.

It's now under development the possibility that other players can be acted by simulation system, see Future development chapter.

Team and individual training is based on a very broad base of research and practice (Pantelli and Duncan, 2004; Bennis 2002; Elfrey1982, Cartwright et al.1960, Schutz, 1958; Argyris et al., 1958; J.L. Moreno 1947 and others).

It's clear that a team composed by unknown people can be easily affected by a lot of problems due to lack of trust. Theories assert that is crucial that trust is developed quickly and it has to be maintained along the whole team action time. In game intent the players will have to accept, negotiate and construct a synthetic trust that is the way to succeed in the game for one of them.

Sibilla starts with the game philosophy:

- The training is about co-operation,
- Players do not have all the necessary information

So no co-operation could mean failure for every player.

With Sibilla trainees play and learn both gather and connect fragments of data in order to operate effectively in a sequence of crisis scenarios in which they deal with limited resources with a sequence of critical events that they have to predict and plan proper counter measures.

The idea arose from an experience carried out with a structured Role-Playing Game (RPG). The reference has a history: "Utilizing Group Resources" adapted by P. Elfrey et al. (2001) from a research by D.Nylen et al (1967), Handbook of Staff Development and Human Relations Training, NTL, which credited version from A. Bavelas, "Communication Patterns in Task-Oriented Groups" in D. Cartwright & A. Zander (1960), Group Dynamics: Research and Theory (Evanston, Ill., Row, Peterson).

The Role-Playing Game implies decision-making with distributed information among a number of players or groups who must share and obtain information that others possess. With no sharing player are unable to make a wise or accurate decision. It has often been used in staff development exercises to provide powerful lessons in focusing on goals and specific situations when working in important time-constrained tasks.

Sibilla is based on similar philosophy and some concept from Tit for Tat game theory (Axelrod 1981) are reused, in fact the game proves effective for teaching people about the importance of sharing knowledge in order to achieve common goals with two fundamental improvements respect the traditional RPGs:

- time-pressured threat,
- computer-based intelligent agents.

The first one is very important for creating realistic stress situation. While the importance of intelligent agents is briefly described in the following paragraph

### *Intelligent Agents For Training*

By the use of Computer Based Intelligent Agents (Bruzzone et al. 2004, 2005) you can have two main advantages:

1. it is possible to reduce personnel involved in the Computer Aided Exercise (CAX) because you have

- the computer that “plays” the enemies role
- every training session is not affected by subjective factors such as staff capabilities to use the tool or expertise in realistic situation.

While the first one is very important for budget constrains the second one is fundamental for successful and objective training development. In fact by the usage of Intelligent Agents acting as players (both friends and foe) the trainees are provided with homogeneous situations and problems to be solved (Bruzzzone et al. 2008). This is very fundamental also for the trainers to evaluate every training session.

### Why Sibilla?

- The title, Sibilla, refers to Sibilla Cumana (the Cumaean Sibyl), an Apollo prophetess from mythological history. The story of Sibilla stressed the importance of situational awareness and attention to details. In fact the story tells that a soldier asked the prophetess if he will return safely from battle and she answered “*ibis redibis non morieris in bello*” (literally: “you go-you come back-not-you die- in war”). It’s immediately clear the importance for a detail: a comma determines real dramatically meaning.
- In fact the phrase can have opposite meanings based on comma place. It can be: “*Ibis redibis, non morieris in bello*”: “You go and come back, you do not die in war.” Or it can be, with the comma moved: “*Ibis redibis non, morieris in bello*”: “You go and You do not come back, You die in war”. Comma placement can mean life or death.
- The Sibilla tale is a metaphor for the importance of precision in communication as well as the challenge that communication presents to mere mortals (it was already crystal clear to Ancient Greece several centuries B.C.).
- The tale fashion was such strong that authors decided to use it for the serious game name where **SIBILLA**, is in reality stays for **S**imulation of an **I**ntelligent **B**oard for **I**nteractive **L**earning and **L**ofty **A**chievements.
- In the game, the participants have to face a crisis, a potential undefined terrorist strike. There is no time for people to learn about one another, go slow and consolidated relationships, nor consider interpersonal relations, for example, from the standard perspective of inclusion, control, and affection.

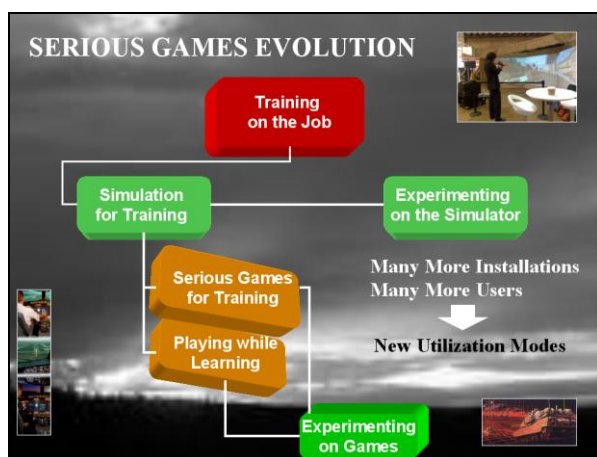


Figure 1. Serious Games Use

### **3. SIBILLA GAME STRUCTURE**

In Sibilla, as we have seen, each player (or a group of players) operates as an agency whose goal is to prevent terrorist's attacks against the nation.

In fact the players in the game operate agencies with similar goals, but with specific budget and resources based on their identity. The participants know that various terrorist organisations are actively engaged in planning and preparing threatening activities. They do not know who or what is most dangerous or credible nor when such attacks might occur, where it may happen or how much and what is at risk (Bruzzzone et al.2003).

The game begins with each agency (playing in the game) provided with some suggestions about the importance of group dynamics in a temporary team, communication, co-operation and collaboration. An initial budget is allocated and it is provided a general review of the risks the nation faces from a set of terrorist groups.

The terrorist organisations are played by agents that decide to plan initially and prepare subsequently attacks in specific town, targets with specific devices and people; during these activities info are collected on different channels and each agency receives these information (usually partial and randomly) based on their efficiency on the info channels; in this way the intelligence agencies collect the information about potential suspected terrorist acts.

At the same time dummy information are mixed to real one.

Every agency has limited resources: funds, data, personnel and time to be allocated in data collection and attacks prevention. If the agency succeed to prevent an attack the next shift it receives more funds.

In fact the National intelligence budget it is shared among the different agencies based on their success rate, therefore the overall budget evolves (increase and decrease) based on the success in preventing or failing in the protective actions; so succeeding in prevention results in a general benefit (the total funds growth) and individual success (National Budget Share of the specific agency increase).

The players must leverage their knowledge, intuition and their budgeted money to improve the quality and quantity of information they have on terrorist activity and suspected subjects.

There are different available channels for collecting data:

- Surveillance of suspects
- Financial and Bank operations
- Police Records
- Informants and Crime Organisations
- Media
- Communication Interception
- Web Watching
- Customs and Border Protection
- Satellites
- Rumours and Answers to inquiries.

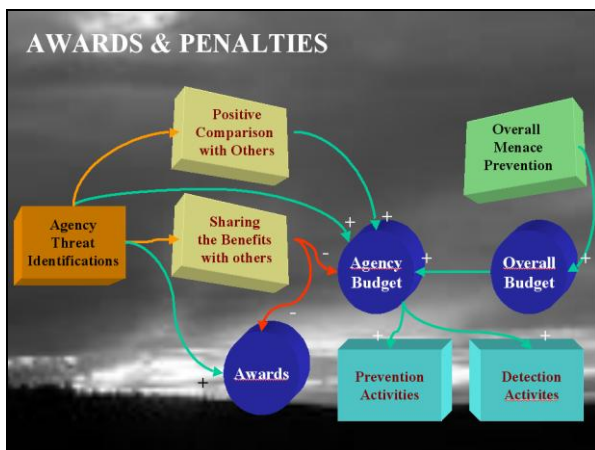
By sharing information and investing money intelligently on these channels, players increase the possibility of getting better evidence and clues that will allow them to understand the nature of the threat or threats and develop counter measures to dismantle.

Players are enable to decide to share, or not, any information with other agencies. The mechanism inside the Sibilla algorithm allows any player/agency to deny collaboration with others or accept and share information based on negotiated exchange of information or money. When teams collaborate they earn credit in terms of trust from the other agencies. It is possible to formalise agreements with other agencies to exchange information. Trust is an important parameter to be considered: because an agency with a lot of credit in term trust has much more opportunities to obtain information from other players.

An important aspect in the game it is represented by Sibilla Awarding Algorithms that is based on a set of matrixes that allow to calculate the rewarding system for every agency.

The more efficient is a player in analysing and preventing attacks the more is awarded, this is summarised in term of budget allocation to the specific agency.

The competition for understanding as fast as possible terrorists plans leads the whole group of players to increase their skills about dealing information and making link between evidence, clue and news.



**Figure 2.** Awarding and Winning Conditions

This happens because when a player understands the plan and makes a correct prevention for dismantle the treat, or an attack took place, all the players understand the meaning of information they had and they can start a rapid on-going review of their action and learning from mistakes. At the end of the game the review system help to understand negative and positive collaboration activity and assess the group dynamics, individual and group communication as well as the level and results of trust and mistrust.

#### 4. SHARING A GOOD WAY TO WIN

In Sibilla share information is important to warranty safety contrasting terrorists organisation with prevention campaign; the main goal of the game is to train people to prevent attacks; dismantle organisation when they are still planning/preparing terrorist actions to pursue their believes and their political issue. During the game terrorists are improving their skills and they efforts to strike their target involving bigger logistic preparation; but the bigger is the attack the more information they leave around. The players collect the data they receive and screen the useful one searching for more evidences about the criminal plans ongoing in terrorist mind (Bruzzzone 2009).



As in the real world terrorists don't spread a lot of information about their activity; intelligence operators have to link small clue coming from various sources like on field observations, customs and border trespassing, financial movement to people assembly and meeting . Small piece of information could results in a big hint for discovering a plan if correctly interpreted, otherwise these can pass unnoticed. Of course some information can be useless or impossible to be interpreted if not linked with others.

In the game it's necessary that antiterrorism agencies identify the proper policy to evaluate the value of the information and decide how to apply it in information sharing. Anti terrorism agents needs to get access from other agencies database and expertise to complete analysis about attack plan. In the game there are several agencies that interact at the same time to protect the national interests.

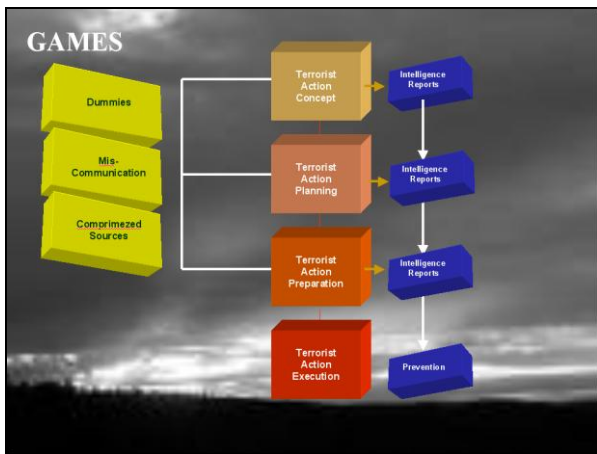


Figure 3 – Sibilla Information Generation Process

All the agencies receive some information random during their activities, but every agency has to invest its budget to find more useful information. So the player has to understand in which direction spend its limited money, but on the other hand he has also develop a good strategy to share already paid information with other players/agencies. Players desperately need more information to scan what they have, more information mean having more chance to understand who, when, where and how is menacing national interests. Every player has to be faster than terrorist, but they have even to be faster than concurrent agencies. In this way it is possible to create a realistic co-operative and competitive environment.

According to game rules it is also very important to analyse and understand which are the good partners for exchanging information. Budget and time are limited and it is important to spend them in the more effective way.

The game provide even the opportunity for Every player to learn criteria devoted to choose which information is convenient to share with other players and which is the correct price or counterpart for sharing; it is also possible to sell false information to other agencies.

In this way Sibilla player has often to negotiate with a human counterpart in his search for information; game architecture improves player negotiation's skill (Bruzzone et al.1998).

Player becomes more conscious about benefit coming from sharing information, but at the same time he develops critical skills and becomes aware of risks to negotiate with subjects outside his own organisation and in competition with him.

Sibilla is a simulator for training personnel with high level in hierarchical structure of intelligence. Player has to deal with other high level agencies; player has to be focused on the strategic scenario instead of

observing details. He obviously is enabled to modify the quality and the orientation of the research of his agencies because players are allowed to modify budget allocation to on-field operator that produces reports.

## 5. THE IEPAL EXPERIENCE

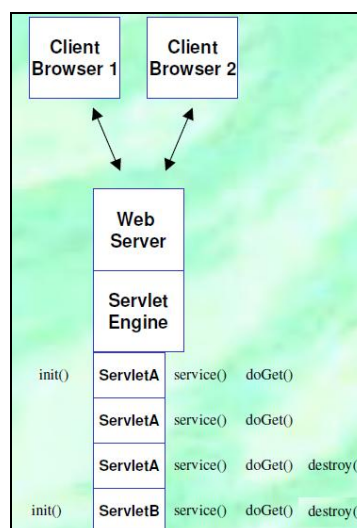
SIBILLA represent the evolution of a set of training experience applied to business in a Transatlantic cooperative framework between USA and European Community. In fact in the beginning of the new millennium it was activated a joint Intensive Educational Program in Advanced Logistics between European Union and USA; in particular the program involved Genoa University (Italy), Magdeburg University (Germany), Marseille University, CFLI (Industrial EU Consortium), Stevens College (NJ USA), Boston College (MA USA), UCF (FL USA) and NCS (Hi Tech USA Consortium). So IEPAL represented a Great Opportunity to experiment Transatlantic Experiences in Enterprises and Universities working on Projects in World-Wide Distributed Teams focusing on the Advances in Modelling & Simulation for Logistics and Supply Chain Management (Elfrey et al.2001)

IEPAL was a flexible educational program for engineering students interested in current and emerging advances in research and applied technology During the internships coordinated by NCS in 2003 the students experienced an RPG (Role Playing Game) for teaching the importance of knowledge share; this RPG was a classical board business game, however its impact on the student was very effective. Since this time the authors involved in IEPAL were evaluating to reuse these concepts to develop a more articulated game framed into a simulator (Bruzzzone & Mosca 2003).

## 6. SIBILLA MODEL STRUCTURE

Model structure under Sibilla Game is based on payment matrix; there are matrix for every player action combination, through these matrix are generated the pay off for the players.

The implementation of Sibilla is based on web technologies as proposed in the following graph



**Figure 4.** Sibilla Web Architecture

The interface for the user is accessible through the web by regular browser as proposed below.



Figure 5. Sibilla Browser Graphic User Interface



Figure 6. Graphics User Interface Attacks menu

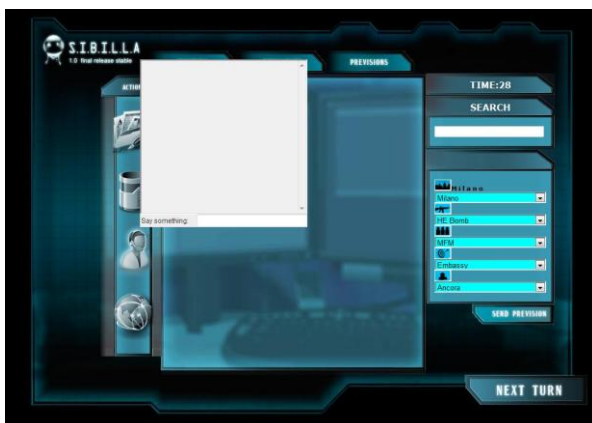


Figure 7 Graphics User Interface Chat

Sibilla is an Object oriented model that involves the following classes (Bruzzone 1996):

- Terrorist Attacks
  - HE Bomb
  - Chemical Weapon
  - IED

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- Radiological Dispersal Device
- Biological Weapon
- Media Attack
- Cyber Attack
- ...
  
- Terrorist Movements
  - Alfa
  - Beta
  - ...
- Terrorist Leaders
  - Mr. X
  - Mr. Y
  - ...
- Locations
  - Rome
  - Milan
  - Turin
  - Genoa
  - ...
- Final Targets
  - Airport
  - Railways
  - Port
  - Stock Exchange
  - Shopping Centre
  - City Hall
  - Educational Institution
  - Company Headquarters
  - ...
- Intelligence Events During Attack Planning
  - Meeting
  - Phone Interception
  - Detection
  - Training Sessions
  - Crossing Custom/Border
  - Arrival At Airport
  - Arrival At Station
  - Arrival At Port
  - Email Interception
  - Web Meeting
  - Teleconference
  - Information Request
  - Symptoms Cyber Attack
  - Detection of CW Compounds
  - Detection of BW Compounds
  - Detection of RDD Compounds
  - Accessing Information on IED
  - Accessing Information on BW
  - Accessing Information on CW
  - Accessing Information on RDD
  - ....
- Intelligence Events During Attack Preparation
  - Money Transfer
  - Explosive Stolen
  - CW Stolen
  - BW Stolen
  - Radioactive Material Stolen
  - Explosive Trade
  - CW Trade
  - BW Trade
  - Radioactive Material Trade
  - Computer Security Violation
  - Password Sniffing

- Suspicious Person Signals
- Suspicious of Infiltration
- Personnel Abnormal Behaviour
- Personnel Disappeared
- Communication Suspicious Noise
- Media Abnormal Information
- Suspicious Contraband
- Weapon Trade
- Nuclear Scientist Disappeared
- Chemical Scientist Disappeared
- Bio-Scientist Disappeared
- Hacker Disappeared
- Psychologist Scientist Disappeared
- Intelligence Agency
  - MIA
  - ICPP
  - IS6
  - ...
- Intelligence Sources
  - Custom & Border Protection
  - Finance
  - Crime
  - Police
  - Network Patrol
  - Governmental Dbase
  - Satellites
  - Field Intelligence
  - ...



**Figure 6.** Sibilla Objects

Sibilla metrics includes different types of scenario matrices; among the others the following functions are pretty important:

- To regulate increase in informative reports related on budget allocation
- To give the pay off for collaboration agreement between agencies
- To allocate national security budget based on agencies results.

The first kind of matrix is unknown to players because it allows calculating probability to find more information about terrorists plans investigating in a particular area (i.e. customs or financial institutions); obviously these chances have to be a variable depending only by terrorist wishes. There isn't an equal distribution of probability; there are some fields that are more likely to give better information to the enquirer depending on terrorist's plans. Numerical value and the function that fill the matrix have to fit the knowledge on the terrorist modus operandi. According to subject matter expert (SME) evaluation it is

possible to create various terrorists behaviours; this kind of matrix can be filled with time-related values that are included in a given stochastic range (Bruzzone et al.2001).

In this development stage the practice adopted to evaluate the fitness to reality of the simulator was to submit the parameters configuration to SMEs judgement for every scenario in which it's intended to develop training sessions (Bruzzone 2007).

The second family of matrixes is the ones for evaluating consequences of agreements on sharing information with other agencies.

At this early stage of simulator development we have implemented the basic payoff structure; anyway the system is devoted to evolve based on the interaction with modules and agents adding complexity and considering additional aspects in the evaluation of the co-operation/competition .

In fact it is possible to use classic game theories (i.e. the prisoner dilemma) for setting up the pay off matrix to evaluate the choice to cooperate between agencies, of course by changing these parameters winning strategies changes. Agencies in reality have much reason for not cooperate with other agencies, but better results for national interest are obtained with collaborations. Players have much more to gain if they trust other. In Sibilla Games the pay off of the matrix assign credits and penalties to agencies after that terrorist actions are discovered or an attack succeed.

When the terrorist plan is clear even because it's happened or because it's dismantled Sibilla simulator let players review the quality of shared information. Players make a synthetic report on their collaboration in which they state only if the collaboration was correct or was just a tricky one. Every player knows the pay off inside this matrix; this helps them to develop their will to collaborate and search for win-win solutions.

The third kind of matrix it's used to distribute the national security budget among players while the simulation time runs. The improvement is calculated considering how many attacks the player has prevented. The player that a sum more dismantled terrorist plan is the first classified. In fact the master of the game is enabled to set-up the matrix; for instance in the following it is presented an example.

	Budget %
1°	28.57143
2°	22.85714
3°	17.14286
4°	14.28571
5°	8.571429
6°	5.714286
7°	2.857143

**Table 1.** Assigned budget

It's set penalties for player that makes a wrong forecast about terrorist plans. In this way there is an increasing gap while time goes by between the firsts and the lasts; it's a sort of natural selection of the fittest.

Currently the authors are developing different strategies and regulation in order to investigate budget variation effects on agencies surviving or effects of different distribution criteria.



## **7. FURTHER APPLICATIONS AND FUTURE DEVELOPMENT**

A game as Sibilla could find useful applications in the study of algorithms for data analysis, identifying modalities through which the entire informative system analyzes and uses the data available, rendering the application of techniques of artificial intelligence in the delicate field of information data fusion. Analyzing the informative flows and identifying the several alternatives of game it could be possible to use the available resources and to realize specific algorithms for optimize the result.

From another point of view, it is possible to find and resolve lack of information or lack of exchange information between different agency and the necessity of more accurate sensors in some particular aspect.

An enhancement of Sibilla under development it is focusing on having other agencies played by computer based intelligent agents. In this way it will be possible to have complete training even for single player.

Another development of this tool is to model the lower levels of intelligence organisations: in this way it will be possible to reproduce the whole chain of information. In the actual version of Sibilla information are provided to player as simple report. It could be more realistic to have to interact with other player (virtual or human) representing hierarchy of the agency.

In addition the new release of the game will consider the possibility to play concurrently multiple scenario where the different players have different co-operation/competition configurations (i.e. co-operating in an area and competing in another one).

Several international joint projects using Sibilla as environment are under evaluation.

There are, for instance, studies to include virtual framework based on game library in use in DIPTeM and LAMCE (Bruzzone et al.1998; Bruzzone et al.2009).

Another joint project under conceptual development with DIPTeM, MAST and VMASC intends to use Sibilla to set up an international scenario that needs support integrated with ELICIT (Experimental Laboratory for the Investigation of Collaboration, Information-sharing, and Trust) to evaluate the information exchange between the partners. The system could be integrated in virtual distributed environment (i.e. 2<sup>nd</sup> Life) to allow training "in one room" even if the participants are in distributed around the world.

Authors are also developing new enhancements of Sibilla, based on interaction with smart phones and PDAs in order to create complex live-constructive scenarios with real people operating on the field interacting with intelligence co-ordination.

## **8. CONCLUSIONS**

Sibilla Game results in an effective training system based on stochastic simulation; so Sibilla provides an opportunity to learn strategies in information management within a competitive/co-operative framework by challenging; in fact the challenges in the serious game provides an effective motivation as well as an effective system for debriefing especially thanks to the quantitative approach in identifying winning strategies and point boundary condition management: this allow to learn important concepts in information management and even to change attitudes.

The web technologies adopted to distribute the game emphasise the effectiveness in organise training sessions even remotely.

Sibilla simulator is currently ready to use for training scope; with further developments devote to support its evolution into an useful tool for training and decision making in more sophisticated scenarios.

A strategic advantage in this context it is represented by intelligent agents developed by the authors for being integrating in reproducing terrorist organisations, competing agencies and lower level in intelligence organisation.

In fact intelligent agents allow to simulate even lower level on intelligence hierarchy for adding more realistic feed back to players and increasing the user number.

Future research programme on this model would look forward even to enhance the portability of Sibilla for letting player use it on PDA or mobile phone. The aim is to run this model on PDA for using it for training staff in augmented reality environment linking with the game.

On the other side authors would like to simulate even lower level on intelligence hierarchy for adding more realistic feed back to players and increasing the user number.



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